HA12181FP
AM Radio Noise Reduction System

HITACHI
ADE-207-171A (Z)
2nd. Edition
June 1997

Functions
• Buffer amp. for audio
• Linear approximate circuit for noise reduction
• IF Amp., detector, audio amp. and AGC circuit for noise detection
• Gate pulse generator

Features
• High noise cancelling capacity: 46 dB typ.
• Less gain loss: $G_v = -0.5$ dB typ.
• Low total harmonic distortion and high signal-to-noise ratio: $THD = 0.06\%$ typ., $S/N = 75$ dB typ.
• Operation supply voltage range: 7.0 V to 10 V (8.2 V typ.)
• Less external parts count
Table of Pin Description and External Parts

<table>
<thead>
<tr>
<th>No. of pin</th>
<th>Name</th>
<th>Function</th>
<th>DC voltage (V)</th>
<th>Equivalent circuit</th>
<th>External parts</th>
<th>Influence of External parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IF AGC</td>
<td>Time</td>
<td>2.7</td>
<td></td>
<td>R500 100 K</td>
<td>Longer than recommended value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C502 3.3 µ</td>
<td>Smaller than recommended value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>time to stabilize AGC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>distortion of recover.</td>
</tr>
<tr>
<td>2</td>
<td>Bias1</td>
<td>Bypass for voltage</td>
<td>3.2</td>
<td></td>
<td>C500 0.033 µ</td>
<td>Increased noise.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stabi.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>AF input</td>
<td>Input of AF.</td>
<td>3.3</td>
<td></td>
<td>C513 1 µ</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bias2</td>
<td>Decide the current</td>
<td>1.3</td>
<td></td>
<td>R506 12 K</td>
<td>Cut off frequency of L-P-F and H-P-F shifted lower.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of filter network.</td>
<td></td>
<td></td>
<td></td>
<td>Cut off frequency of L-P-F and H-P-F shifted higher.</td>
</tr>
<tr>
<td>5</td>
<td>Phase</td>
<td>Phase circuit</td>
<td>3.3</td>
<td></td>
<td>C512 0.068 µ</td>
<td>Must be used on the recommended value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<th>Influence of External parts</th>
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<tbody>
<tr>
<td>6</td>
<td>Hold</td>
<td>Hold of level difference.</td>
<td>3.3</td>
<td>![Equivalent circuit diagram]</td>
<td>C511</td>
<td>0.033 µ</td>
<td>Must be used on the recommended value.</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>High-Pass AMP. (Waveform Compensation)</td>
<td>3.3</td>
<td>![Equivalent circuit diagram]</td>
<td>C510</td>
<td>0.033 µ</td>
<td>Must be used on the recommended value.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>AF out</td>
<td>Output of AF</td>
<td>3.3</td>
<td>![Equivalent circuit diagram]</td>
<td>C508</td>
<td>1 µ</td>
<td>Output DC cut</td>
</tr>
<tr>
<td>10</td>
<td>Waveform Compensation</td>
<td>3.3</td>
<td>![Equivalent circuit diagram]</td>
<td>C509</td>
<td>0.033 µ</td>
<td>Must be used on the recommended value.</td>
<td></td>
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<tbody>
<tr>
<td>11</td>
<td>Gate</td>
<td>Pulse generation Gate</td>
<td></td>
<td></td>
<td>R503 180 K</td>
<td>Gate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C507 2200 P</td>
<td>Gate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pulse width become wider.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pulse width become narrow.</td>
</tr>
<tr>
<td>12</td>
<td>Vth</td>
<td>Determination of noise detection sensitivity</td>
<td>1.1</td>
<td></td>
<td>R502 22 K</td>
<td>Higher noise detection sensitivity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower noise detection sensitivity.</td>
</tr>
<tr>
<td>13</td>
<td>Vcc</td>
<td>Vcc</td>
<td>8.2</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>14</td>
<td>IF Det.</td>
<td>IF AGC detector</td>
<td>3.3</td>
<td>C503 0.01 µ</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>15</td>
<td>AF</td>
<td>Time AGC constant for AF AGC</td>
<td>0</td>
<td>R505 47 K</td>
<td>Longer</td>
<td>Miss-operaton in noise detector.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C504 0.22 µ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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</tr>
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<tbody>
<tr>
<td>16</td>
<td>IF in</td>
<td>IF input 1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Equivalent Circuit Diagram]

Absolute Maximum Ratings (Ta = 25°C)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{cc}$</td>
<td>16</td>
<td>V</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_d$</td>
<td>400\textsuperscript{\textdegree}</td>
<td>mW</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>$T_{opr}$</td>
<td>−40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>−55 to +125</td>
<td>°C</td>
</tr>
</tbody>
</table>

Note: 1. Value at Ta = 85°C
**Electrical Characteristics** (Tentative) \( (V_{cc} = 8.2\ V, \ Ta = 25^\circ C, \ Pin\ 3\ input:\ Vin = 100\ mV_{rms},\ f = 1\ KHz,\ Pin\ 16\ input:\ Vin = 74\ \text{dB}\mu, \ fc = 450\ KHz,\ fm = 1\ KHz,\ m = 30\%) \)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Test conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply current</td>
<td>( I_{cc} )</td>
<td>—</td>
<td>11.0</td>
<td>—</td>
<td>mA</td>
<td>No input signal, IC only</td>
</tr>
<tr>
<td>Output voltage</td>
<td>( V_{out} )</td>
<td>70</td>
<td>95</td>
<td>120</td>
<td>mV_{rms}</td>
<td>Pin 3 input only</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td>THD1</td>
<td>—</td>
<td>0.06</td>
<td>0.3</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Signal-to-noise ratio</td>
<td>S/N (1)</td>
<td>60</td>
<td>75</td>
<td>—</td>
<td>dB</td>
<td>Pin 3 input Vin = 100 mV_{rms} (Reference), ( R_g = 10\ \text{K}\Omega )</td>
</tr>
<tr>
<td>Strong input total harmonic distortion</td>
<td>THD2</td>
<td>—</td>
<td>1.0</td>
<td>2.5</td>
<td>%</td>
<td>Pin 3 input Vin = 500 mV_{rms}</td>
</tr>
<tr>
<td>Recovered output voltage</td>
<td>( V_o (AF) )</td>
<td>50</td>
<td>78</td>
<td>120</td>
<td>mV_{rms}</td>
<td>Pin 16 input only</td>
</tr>
<tr>
<td>Recovered output signal-to-noise-ratio</td>
<td>S/N (2)</td>
<td>35</td>
<td>45</td>
<td>—</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Noise suppression ratio</td>
<td>NSR</td>
<td>35</td>
<td>46</td>
<td>—</td>
<td>dB</td>
<td>Input the waveform below. Pin 3 input Vin = 100 mV_{rms} (Reference) no input sine wave</td>
</tr>
</tbody>
</table>

Figure 1  Input Waveform at Measurement of Noise Suppression Ratio
Test Circuit

![Test Circuit Diagram]

Note: 1. Resistors tolerance are within ±5%.
2. Capacitors tolerance (C509 to C512) are within ±5%, other capacitor are within ±10%.

Operation Principle

![Operation Principle Diagram]

Figure 2  System Block Diagram of AM Radio
A system block diagram of AM Radio using the HA12181FP is shown in Figure 2 and waveforms at each point in the system are illustrated in Figure 3. For AM wave with impulse noise from ANT, the pulse spreads its width each time when the AM wave passes through a selection filter.

The pulse width becomes the order of several hundred microseconds at detector output (Point C).

A radio without a noise canceller produces large noise to the audience. This IC perfectly detects every noise by using the signals from 1st IFT (Point B) in front of the narrow band filter.

The wave process circuit approximates the voltage linearly at the pulse to reduce the noise in the output.

The principle for wave processing follows. Further investigation make it clear that the pulse width of impulse noise is constant (several hundred microseconds) and independent of the waveform or waveheight.

Therefore the former and later voltage (VA, VB) of the pulse can be found at the same time (T1) by means of the wave and the delayed one for this time, as shown in the right figure.

<table>
<thead>
<tr>
<th>Each Point in the Figure</th>
<th>Waveform including Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Narmer Pulse Width and Higher Wave Height</td>
</tr>
<tr>
<td>B</td>
<td>Wider Pulse Width and Lower Wave Height</td>
</tr>
<tr>
<td>C</td>
<td>Noiseless</td>
</tr>
</tbody>
</table>

![Figure 3 Waveforms at Each Point in the System](image)

In an actual circuit, the differential voltage between input and output of phase shift circuit is changed to the capacitor C511 at pin 6.

At the time of T1, when the switch turns to the noise processing mode (the switch positions in Figure 4 are inverted), the voltage difference (VA – VB) is held in C511.

C509 at pin 10 is changed by the differential voltage between the held voltage and the output voltage at pin 9 (VA): VA – (VA – VB) = VB.
As the initial voltage of C509 is equal to the output voltage (VA) before the switch change, the voltage between terminals of C509 is changed from VA to VB.

The waveform which change up to C509 becomes the output, because the voltage of C509 appears at pin 9 through the buffer.

The changed up waveform of C509 is almost linearly approximated because of the constant current change by the feedback from the output at pin 9.

At the time of T2 when the switches change to the normal mode (the switch position in Figure 4), the output recovers smoothly as the voltage of C509 is VB.

However the unmatch of the wave delay time due to the pulse width or the phase circuit and the offset of circuit make a slight step difference on the waveform at the moment of switch change.

LPF, consisting of R1 and C509 make it smooth.

The frequency characteristics, which is detriorated by LPF in the normal mode, is compensated so that it might become flat. C509 and C510 should have the same capacity, and the tolerance must be within ±5%.

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**Figure 4  Waveform Processing Circuit**
Evaluation Circuit for Noise Reduction Effect

[Diagram of the circuit with various components and connections, including IF, RF, OSC, AGC, and other identifiers.]
Example of Noise Reduction Effect

\[ \text{AM SG Output (EMF) (dB}) \]

-60  -50  -40  -30  -20  -10   0   10   20   30   40   50   60   70   80   90   100   110   120

VCC = 8.2V
AM SG : fc=999kHz, m=30%, fm=1kHz
Pulse : No input

Vout

NRon

NRoff

Noise

AM SG : fc=999kHz, no mod.
Pulse SG : Refer to Figure.2

Pulse SG Output (EMF)

Figure.2

Pulse SG

AM SG

To ANT

Two Signals dummy ANT.

Pulse SG. AM SG.

100mV P-P

10\mu s

10\mu s

Vout

NRon

NRoff

Noise

AM SG : fc=999kHz, no mod.
Pulse SG : Refer to Figure.2

Figure.3

Pulse SG Output (EMF)

100mV P-P

VCC = 8.2V
AM SG : fc=999kHz, m=30%, fm=1kHz
Pulse : No input

Output (dB)

Output (dB)

AM SG Output (EMF) (dBμ)

AM SG Output (EMF) (dBμ)
PC Board Layout Pattern

(Top view)

(Bottom view)
Main Characteristics

![Diagram showing voltage output (Vout) in dB versus frequency (f) for different input voltages (Vin) and THD values.](image)

- **Vout : Vin = 100 mVrms const**
- **Vout (0 dB = 96 mVrms)**
- **Vin Max (THD ≥ 1.0%)**

![Diagram showing THD (%) versus frequency (f) for a 100 mVrms input.](image)

- **Vin = 100 mVrms**
**Vin (EMF) (dBµ)**

-70  -60  -50  -40  -30  -20  -10  0  10  20  30  40  50  60  70  80  90  100  110  120

**Vout (dB)**

**Vo (AF): 0 dB = 76 mVrms**

- fc = 450 kHz, m = 30%, fm = 1 kHz

- Noise (no modulation)

**V pulse (mVp-p)**

- 10µs
- 2ms

**R (Ω)**

- 1 k 5 k 10 k 100 k 50 k
Vin = 74 dBµ
f0 = 450 kHz
fm = 1 kHz
m = 30%

S/N2 (dB)
Vo (AF) (mVrms)

NSR (pulse input)
Icc (no-input)
1. V pulse (mVpp) vs. VCC (V)

2. THD1 (%) vs. Ta (°C)

VCC = 8.2 V
Vin = 100 mVrms, f = 1 kHz
Package Dimensions

Unit: mm

Hitachi Code | FP-16DA
---|---
JEDEC Code | —
EIAJ Code | SC-530-16C
Weight | 0.24 g
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